Mackenzie
Forest District

Vegetation Resources Inventory

Strategic Inventory Plan

PREPARED BY:

MINISTRY OF FORESTS
RESOURCES INVENTORY BRANCH

DRAFT FOR DISCUSSION

20 DECEMBER 2000

106-05146/

EXECUTIVE SUMMARY

This Vegetation Resources Inventory (VRI) Preliminary Strategic Inventory Plan (VSIP) outlines the VRI activities and products that address forest management and inventory issues in the Mackenzie Forest District (MFD), as identified at the November 21, 2000 stakeholders meeting. The stakeholders include the Ministry of Forests, Ministry of Environment Lands and Parks, Ahibiti Consolidated Inc, and Slocan Forest Group Inc.

The stakeholders identified the following VRI activities and products:

1. Conduct a Phase I photo-interpretation retrofit or new photo interpretation over the entire District. The Phase I database will support timber-emphasis inventories, habitat mapping, ecosystem mapping, riparian mapping, and other applications over the district.
2. Conduct timber emphasis ground sampling in the Vegetated Treed area of the District to provide statistically valid timber volumes and polygon-specific tree attributes for the timber supply review in the Mackenzie TSA in 2006. The ground sampling will include Net Volume Adjustment Factor (NVAF) sampling to check loss factors and taper equations in the balsam leading stands, and to check taper equations in the small pine stands.
3. Conduct finer polygon delineation and timber emphasis ground sampling in the deciduous stands and mixed-deciduous stands in the MFD to improve species composition descriptions and spatial data for these stands.
4. Install a monitoring program in the MFD to provide baseline non-spatial data for monitoring the changes and trends over time of timber and non-timber resources. These data could be used to check growth and yield predictions and to support future market certification requirements.

The approximate number of ground sample plots and costs for the proposed VRI activities are given in Table 8 of this report.

These VRI activities and products will support the District objectives and other resource specific interpretations. They may be implemented in smaller units (e.g., Management Zones) across the District. They may also be jointly implemented to address common District issues within the Prince George Region.

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1. INTRODUCTION

1.1 Background

This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines VRI activities and products needed to address forest management and inventory issues in the Mackenzie Forest District (MFD), as identified by stakeholders at the November 21, 2000 meeting. The VSIP provides details for photo interpretation, timber emphasis ground sampling, and monitoring sampling in the MFD. After VSIP approval, the next steps are the preparation of project implementation plans (VPIPs) based on this VSIP, and the implementation of the VPIPs.

The Ministry of Forests (MOF) Resources Inventory Branch (RIB) prepared this report in consultation with the MFD stakeholders. These stakeholders included the Ministry of Forests (MOF), Ministry of Environment Lands and Parks (MELP), Ahibiti Consolidated Inc., and Slocan Forest Group Inc. This preliminary VSIP will be reviewed and verbally approved by the District stakeholders during a December 12, 2000 conference call. Comments from the conference call will be incorporated into the final VSIP.

1.2 VRI Overview

The VRI is a new vegetation (forest) inventory process that has been approved by the Resources Inventory Committee (RIC) to assess the quantity and quality of BC's timber and vegetation resources. The VRI estimates overall population totals and averages, as well as individual polygon attributes, for timber and non-timber resources. Its design is simple, reasonably efficient, statistically defensible, and addresses issues raised by the Forest Resources Commission in its 1991 report, *The Future of Our Forests*.

The VRI consists of several components (Appendix II):

1. BC Land Cover Classification Scheme (BCLCS)
2. Photo Interpreted Estimates (Phase I)
3. Ground Sampling (Phase II) – timber emphasis, ecology, coarse woody debris
4. Net Volume Adjustment Factor (NVAF) sampling
5. Within Polygon Variation (WPV) sampling
6. Statistical Adjustment.

One or more of these components can address specific forest management or inventory issues. An overview of VRI design was presented at the stakeholder meeting. For more information, VRI manuals are available on the internet at **http://www.for.gov.bc.ca/resinv/veginv/publications.htm.**[1]

1.3 VRI Planning

The VRI planning process for management inventories develops VSIPs and VRI project implementation plans (VPIPs) for defined areas, e.g. a Forest District. A VSIP outlines VRI products to address forest management issues and provides strategic direction for implementing the District inventory activities. A VPIP details the operational activities identified in the VSIP (e.g., ground sampling or photo interpretation projects) and identifies project areas, priorities, plot location, yearly inventory costs, and roles and responsibilities. Guidelines for preparing the VSIPs and VPIPs are available on the Internet at **http://www.for.gov.bc.ca/resinv/veginv/project_management.htm.**

The VRI planning process for management inventories (points 2-4 noted below) is an important component of the overall VRI process and related activities (Figure 1; Appendix III). The intent of the VRI planning process is to ensure that baseline products meet a range of applications and are efficiently implemented. These processes and activities include:

1. Forest management decision processes (land integration planning)
2. Identifying forest management issues
3. VRI Strategic planning (VSIP)
4. VRI District operational planning (VPIPs)
5. Implementation, including development and maintenance of procedures and standards;
   a) Management inventories
   b) Database management
6. Data interpretation, including ecosystem and habitat mapping

The steps for preparation of a VSIP include:

1. The MOF and MELP staff request stakeholders to develop Issues Statements and forward them to MOF RIB.

[1] Contact Keith Tudor, MOF Resources Inventory Branch, Victoria (if accessing this website is difficult), or obtain manuals from Superior Reprographics, #200-1112 West Pender Street, Vancouver, BC V6E 2S1.

2. The MOF RIB prepares a VRI "Forest Management and Inventory Issues Discussion Paper".

   This paper explains the VRI process and identifies key issues known to date. Issues are usually taken from the Timber Supply Review Data Package, plus any other issues identified by stakeholders in Step 1. This discussion paper is circulated before the VSIP meeting.

3. A VRI Stakeholders meeting is held. The functions of this meeting are to:

   - Introduce the VRI tools and process
   - Table new issues and issues recorded to date
   - Discuss issues that can be funded or not (under current funding mechanisms); this discussion provides general direction for developing the VSIP. This discussion also affects the extent of photo interpretation and the number and type of VRI plots done where.
   - Suggest the VRI tools to address currently fundable issues as well as those issues that may be funded in the future.

   This meeting is key for all stakeholders; they need to attend it, to table issues and discuss why these issues need to be considered fundable.

4. VRI Stakeholder meeting minutes are prepared by the MOF RIB and circulated to all participants for review and feedback.

5. A preliminary VSIP is prepared by the MOF RIB and discussed by the stakeholders at a conference call.

6. A final VSIP is prepared by RIB and is signed off by stakeholders, MOF and MELP.

7. VPIP process starts

The steps for preparation of a VPIP include:

1. Review and update VSIP recommendations
2. Secure funding
3. Identify project activities, geographic areas, and costs
4. Specify roles and responsibilities for project implementation
5. Prepare VPIP

1.4 Funding

Stakeholders, led by the District, develop criteria for setting VRI activity priorities and products identified during the planning process. Inventory funding, or follow-up resource-specific management interpretations, is excluded from the planning process since funding mechanisms vary. Currently, funding is a regional responsibility that is addressed by regional staff at VRI planning meetings. However, while funding is excluded from actual VRI Plans, it is a key function of the VSIP meetings to discuss what issues can be funded or not (under current funding

mechanisms) in order to determine the Plan content. The VSIP and VPIPs should be considered in submissions by the Region to Forest Renewal BC or other funding agencies.

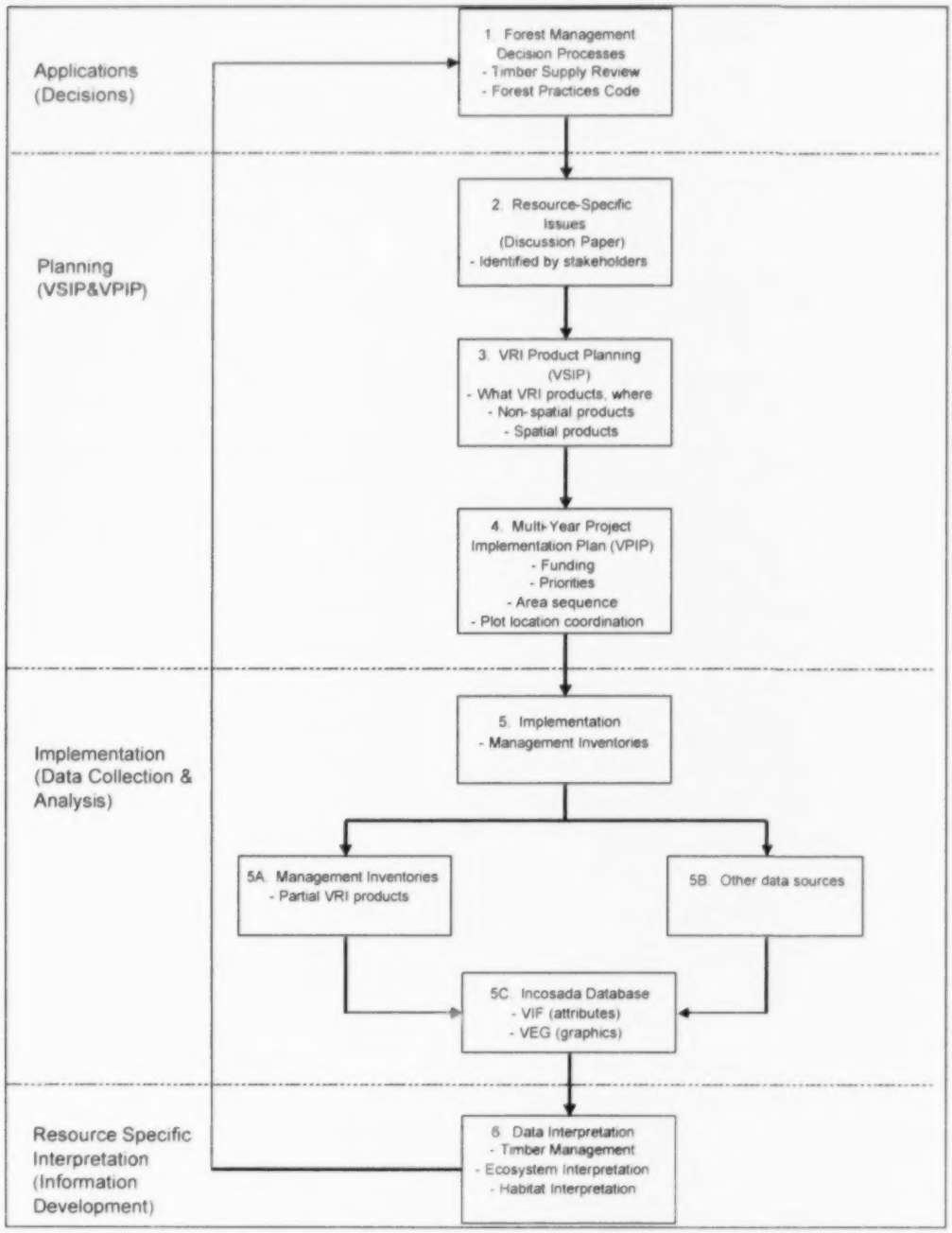

Figure 1. The VRI management inventory process.

2. BUSINESS CONSIDERATIONS

2.1 Landbase

The MFD is approximately 6.4 million ha, of which about 3.4 million ha are forested (Table 1). The main tree species in the forested landbase are lodgepole pine (37%), spruce (32%), balsam (25%), and deciduous (6%) (Table 2). We assume in this report that the forested landbase corresponds to the Vegetated Treed (VT) landbase (BC Landcover Classification Scheme, or BCLCS)

Table 1. MFD landbase by forest cover.[2]

Forest cover	Area (ha)	%
Forested	3,391,447.3	52.9
Mature	2,305,845.7	35.9
Immature	943,419.9	14.7
NSR	97,601.8	1.5
Non commercial	44,579.4	0.7
No typing available	0.4	0.0
Non productive	3,022,875.1	47.1
Grand Total	*6,414,322.4*	*100.0*

2.2 Forest Management Considerations

Significant forest management issues in the Mackenzie TSA (and pertinent to the MFD) were highlighted in the timber supply review data package (Table 3). Use of the VRI to address these issues is identified in Table 3 but the relative importance of the VRI on these issues is not indicated. For example, it does not show that a statistically accurate timber volume estimate may be more relevant than all other issues combined. Yet completing a VRI is considered by the forest industry to be a critical project in the Mackenzie.

Table 2. MFD forested landbase by species

Leading species	Area (ha)	%
Lodgepole pine	1,240,700.9	36.6
Spruce	1,068,077.2	31.5
Balsam	843,541.0	24.9
Aspen	207,341.9	6.1
Birch	23,471.8	0.7
Cottonwood	8,235.2	0.2
Other*	75.6	0.0
No species label	3.5	0.0
Grand Total	*3,391,447.3*	*100.0*

*Douglas fir, cedar, hemlock and larch

The following emerging data needs were considered at the stakeholder meeting:

1. Park inventories
2. Check growth and yield predictions
3. Meet market certification requirements

[2] Data from the new TSR database using the new District boundary; the data summaries were provided by Jennifer Pollard, Data Administrator GIS Analyst, MOF, Prince George Forest Region

Table 3. Forest management issues and the use of the VRI to address issues in the MFD.

	Issue[3]	VRI Implication		Remarks
		Photo-Interpretation (Phase I)	Ground Sampling (Phase II)	
1.	Stand-level volume estimates: ensure that data supporting TIPSY reasonably estimate regenerated stand volumes in the TSA.	Required	Required	Volume estimates from a monitoring program or VRI could provide immature stand data to check TIPSY estimates.
2.	Operability criteria: re-examine operability and merchantability criteria in light of the re-inventory.	Required	Required	VRI may provide additional inventory information to assist the examination of these criteria.
3.	TSA inventory: conduct re-inventory of landbase, particularly northern portion	Required	Required	VRI photo-interpretation and ground sampling will provide updated inventory information for the landbase. The photo-interpretation inventory is incomplete, and the volumes are inaccurate (according to the inventory audit).
4.	Non-recoverable losses: re-examine unsalvaged losses from the Fort Ware fire and forest health	Required	Required	VRI ground sampling may provide additional information on un-salvaged losses from health (balsam, spruce, pine beetles); the data are needed to as inputs to risk rate models.
5.	Archaeological assessment: incorporate archaeological information into next TSR	Required	Required	There is potential to use VRI data in modeling.
6.	Proposed Protected Areas: consider effects of protected areas on TSR determination	Required	Optional	Spatial adjusted or unadjusted data and land classifications from VRI could help in delineation of protected areas.
7.	Deciduous stands: improve inventory and spatial timber distribution of these stands.	Required	Required	VRI photo-interpretation and ground sampling will provide a better inventory of deciduous stands.
8.	Grazing: consider new grazing opportunities and maintain existing grazing tenures	Required	Required	Plant lists and spatial data from VRI may help to identify new grazing opportunities.
9.	Botantical forest resources: maintain the opportunity for the sustainable use of botanical forest products such as wild berries, mushrooms and medicinal plants	Not required	Required	See Issue #8.

[3] Issues compiled from: (1) Timber Supply Branch. 2000. Forest Management Issues Identified Through the AAC Determination Process, District/TFL Timber Supply Reviews: 1992-1996 (revised). (2) Land Use Coordination Office. 2000. Mackenzie Draft Recommended Land and Resource Management Plan and (3) stakeholder input.

	Issue[3]	VRI Implication		Remarks
		Photo-Interpretation (Phase I)	Ground Sampling (Phase II)	
10.	Landscape unit planning and stand-level biodiversity: assist Forest Practices Code land management planning decision processes, LRMP resource management zones delineation and management prescriptions	Required	Required	Spatial data from photo-interpretation and plant lists, forage production, lichen production and shrub transects from ground sampling may provide additional information for riparian area designation, wildlife tree patches, coarse woody debris levels, seral stage distribution, successional effects, ungulate winter ranges. The sampling design employed (plot types and distribution) affects the degree of plot support for ecosystem, habitat mapping and SIBEC. Some supplemental sampling may be needed to pick up areas missed.
	a) Cariboo habitat: area within "Area Specific Caribou Management Strategy #1" (LRMP, see appendix D) is a priority; mainly associated with pine types.	Required	Required	VRI photo-interpretation and ground sampling may help to interpret caribou habitat using a range of attributes (crown closure, age, tree height, site index, and duff layer, ground lichen presence and " cover)
	b) Grizzly bear habitat: Forest District habitat mapping with primary issue areas are: c) High and Spring use grizzly bear habitat (LRMP, see page 71 and appendix F)	Required	Required	Photo-interpretation will provide a polygon base for ecosystem mapping. Ground samping: no specific stratum identified. Use stratum sampled with plot types Q, V and Z, put in to address other issues. Supplement later with post VRI sampling.
	d) Rare plant associations: 3 blue-listed plant associations: Subalpine Fir – Black Spruce / Labrador Tea PA (within ESSF mv2/03, mv3/03, mv4/03) Subalpine Fir / Alder / Horestail PA (within ESSF mv4/05) Black Spruce / Black Huckeberry / Coltsfoot PA (within SBPS mc/03, SBS mc2/03, mc3/05, mc3/06, wk2/04, mk1/06, mk2/04)	Required	Required	Photo-interpretation will provide a polygon base for ecosystem mapping. Ground sampling will provide plot data to support ecosystem mapping. Use VRI-based ecosystem mapping as a coarse filter interpretation to identify areas of potential for these occurrences, and conduct follow up inventory.
	e) Old growth / biodiversity guidelines for the Forest District: priority area is the ESSF zone in the eastern (high grizzly use) portion of the district	Required	Required	Better identification of old growth from VRI to answer the timber age question (250 year for old). Potential to use VRI to define old growth based upon attributes in addition to age.
	g) Seral stage diversity for biodiversity implementation	Required	Required	

Issue[3]	VRI Implication		Remarks
	Photo-Interpretation (Phase I)	Ground Sampling (Phase II)	
11. Succession effects on caribou habitat: VRI based ecosystem mapping plus structural stage succession processes analyses as basis for setting management objectives for Caribou habitat. Key area within the Klawli RMZ for the Wolverine Caribou Herd.	Required	Required	This issue requirs remeasurement data over time.
12. Parks management – to support new initiatives toward ecosystem-based parks management. Total Land Base management – to support assessing the contribution of unmanaged areas (parks and protected areas) in meeting FPC requirements or for other assessments. Mackenzie LRMP protected areas need to be included in VRI inventories. These are listed in Table 4.	Required	Supportive	VRI supports ecosystem mapping and further analysis to produce information using various indicators (e.g. ecosystem representation) for various decision processes, including within parks management and for total land base assessments over managed and unmanaged lands.

Table 4. List of Mackenzie parks and protected areas.

Type[4]	Name	
Ecological Reserve	Chunamon Creek E.R.	Patsuk Creek E.R.
	Raspberry Harbour E.R.	Blackwater Creek E.R.
Proposed Protected	Ed Bird Estella Lake	Ospika Cones
	Chase	Kwadacha Addition
	Muscovite Lake	Omineca
	Heather Dina Lake	Frog-Gataga
	Pine Pass	Finlay-Russel
Provincial Park	Bijoux Falls	Kwadacha Park
	Tudyah Lake	Tatlatui

2.3 Summary of Inventory Issues

The following inventory issues were identified at the stakeholder meeting:

1. Check regenerated stand volume estimates from TIPSY models
2. Operability delineation
3. Quantify non-recoverable (gross) losses from beetle (balsam, pine and spruce) infestations
4. Park inventories

[4] The total area of the Ecological Reserves, Protected Areas, and Parks is approximately 886,642 ha.

5. Check and update species composition labels for deciduous and mixed-deciduous stands
6. Confirm accuracy of balsam loss factors and small pine and balsam taper equations
7. Elk winter range
8. The overall timber inventory still appears to be over-estimated despite a new photo interpretation (Phase I) inventory.[5]
9. Caribou corridors
10. Certification
11. Data management

2.4 VRI Activities and Products

The following VRI activities and products are needed to address the forest management issues in the District. These recommendations are based on the issues identified in Table 3 and Section 2.3, including the discussions at the stakeholders meeting.

1. Conduct a Phase I photo-interpretation retrofit or new interpretation over the entire District. The Phase I database will support timber-emphasis inventories, habitat mapping, ecosystem mapping, riparian mapping, and other applications over the district.
2. Conduct timber emphasis ground sampling in the Vegetated Treed area of the District, to provide statistically valid timber volumes and polygon-specific tree attributes. These data will support the timber supply review (TSR) in the Mackenzie TSA in 2006. The ground sampling will include Net Volume Adjustment Factor (NVAF) sampling to check loss factors and taper equations for the balsam leading stands, and to check taper equations for the small pine stands.
3. Conduct finer polygon delineation and timber emphasis ground sampling in the deciduous stands and mixed-deciduous stands in the MFD, to improve species composition descriptions and spatial data for these stands.
4. Install a monitoring program in the MFD, to provide baseline non-spatial data (timber, ecology, and coarse-woody debris) for biodiversity purposes, and data on changes and trends over time of timber and non-timber resources. These change data could be used to check growth and yield predictions and to support future market certification requirements.

A preliminary strategic inventory plan to address the identified products so far is outlined in the next section.

[5] A comparison of the new photo interpretation with the existing audit samples established in 1997 indicated that the volumes were still over-estimated: the ratio of ground volume to the inventory volume was approximately 0.8.

3. STRATEGIC INVENTORY PLAN

3.1 Overview

This section outlines a preliminary strategic inventory plan to develop specific VRI products discussed in Section 2.4. The VRI products include a new or retrofitted spatial vegetation inventory (Phase I) over the entire district landbase, a timber emphasis inventory in the vegetated treed landbase and the deciduous component, and a monitoring program over the entire district. These products can be obtained through completion of VRI photo interpretation, ground sampling and statistical adjustment.

3.2 Photo-Interpretation

3.2.1 Objective

The objective is to improve District polygon information – especially in areas where specific management issues occur – using photo interpretation. The VRI product is a spatial database consisting of unadjusted photo-interpreted estimates. Ground sampling, used to check and adjust the photo-interpreted estimates, is discussed as a separate process (Section 3.3).

3.2.2 Target Area

The entire District should be updated either through a Phase I retrofit or new photo-interpretation (Section 3.2.4). The southern portion of the landbase was recently re-inventoried; the northern portion was inventoried in the early 1970's with late 1960's aerial photography. The stakeholders will determine the methods for the retrofit; they will also set priorities for the retrofit (e.g., concentrate the retrofit on the southern portion of the district).

3.2.3 Target Attributes

All attributes listed on the VRI photo interpretation attribute form should be targeted. These attributes should be interpreted to the VRI photo-interpretation standards.

3.2.4 Methods

The Phase I information will be obtained through retrofit using a combination of new aerial photography, conventional 1:15,000 scale black and white photos (where available), scanned imagery, and TRIM II photography. Bio-terrain mapping and ecological mapping (e.g. predictive ecosystem mapping), if available, may provide estimated data in addition to the Phase I.

Acquisition of new aerial photography is essential to support Phase I VRI photo-interpretation and spatial mapping in the MFD. To retrofit the existing timber inventory to VRI Phase I standards, 1:30,000 scale color photography is recommended. This is the MOF's provincial

standard for softcopy photogrammetry and will improve identification of species composition for deciduous and mixedwood vegetated cover. Color photography may also improve detection of tree groups severely affected by disease or insect.

Retrofitting using the 1:30,000 scale color photos will be undertaken in the southern areas of the district with a relatively recent (post 1990) timber inventory. The northern areas with very out-dated (pre-1980) timber inventory will be completely re-stratified or delineated using either conventional 1:15,000 scale black and white photos (where available), or soft photogrammetry using scanned imagery. For Parks, Protected Areas, Ecological Reserves and wildland (resource management zones (RMZ) where little or no disturbance has occurred in the past five years, scanned images from the 1:35,000 scale black and white TRIM II photography may be an alternative.

3.3 Timber Emphasis Inventory – Vegetated Treed Areas

3.3.1 Inventory Objectives

The proposed objective of the timber emphasis inventory is to:

> *Install adequate samples to adjust the timber inventory in the Vegetated Treed (VT) areas of the District, to achieve a sampling error of ±10% (95% probability) for overall net timber volume in the VT area, and reasonably accurate individual polygon adjusted estimates.*

Stakeholders agreed to focus the sampling over the entire VT areas rather than the timber harvesting landbase (THLB) because most (80%) of the VT area is in the THLB. This approach also eliminates the problems associated with weighting data if disproportionate numbers of samples were used in the THLB and the non-THLB of the VT areas. Net timber volume is gross volume less stumps, tops, decay, waste, and breakage. Decay and waste will be estimated using VRI call grading/net factoring and NVAF sampling. Breakage will be estimated using existing loss factors.

3.3.2 Target Population

The target population would be the District VT landbase (forested land) (Table 2).

3.3.3 Sample Size

An estimated minimum of 140 sample clusters[6] should be installed in the VT area. These samples would be distributed among leading-species strata proportional to their area (Table 5). The proposed minimum sample size would achieve a sampling error of approximately ±7% (95% probability) for net timber volume in the VT area, assuming an estimated coefficient of variation (CV) of approximately 41%.[7]

Table 5. Approximate distribution of plots.

Leading Species	Area (%)	Number of plots
Lodgepole pine	36.6	51
Spruce	31.5	44
Balsam	24.9	35
Other *	7.1	10
Grand Total	*100.0*	*140*

*Aspen, birch, cottonwood, Douglas fir, yellow pine and willow

3.3.4 Sampling Approach

VRI Timber Emphasis Plots (TEP) should be used to gather data following the current VRI Ground Sampling Manual. The measurements would include timber attributes and coarse woody debris (CWD). These TEPs would provide a sampling framework for additional sampling, such as monitoring (where a subset of the TEPs would be re-measured over time; Section 3.5).

3.3.5 Sample Selection

Sample polygons would be selected using the MOF's standard stratified probability proportional to size with replacement (PPSWR) sampling method.

3.3.6 Net Volume Adjustment Factor Sampling

NVAF sampling should be conducted to adjust net volume. This sampling provides factors to adjust net tree volume estimated using net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves:

- detailed stem analysis of sample trees
- calculation of actual net volume
- calculation of the ratio between actual net volume and estimated net volume.

Table 6. NVAF sample locations and trees.

Leading Species	Number of Trees (Sample Locations)			
	Immature	*Mature*	*All ages*	*Total*
Conifer*	30 (10)	30 (12)	-	60 (22)
Small pine	-	-	30 (8)	30 (8)
Balsam	-	30 (10)	-	30 (10)
Deciduous	-	30 (10)	-	30 (10)
Non-VT	-	-	10 (4)	10 (4)
Dead	-	-	10	10
Grand Total	*30 (10)*	*90 (32)*	*50 (12)*	*170 (54)*

*Includes pine, spruce, and balsam; a deciduous component is included in immature stratum.

[6] The minimum sample size increased from 125 (as previously discussed at the stakeholder meeting) to 140 because of changes in the leading-species relative areas (Table 2).

[7] This CV is for the ratio of actual volume to estimated volume, and inflated by 25% (to account for differences in the VRI and inventory audit plot-cluster designs). The actual volume is based on the 47 inventory audit plots installed in 1997 and the estimated volume is based on the new Phase I.

Estimated net volume is obtained from net factoring and taper equations. The stakeholders agreed that at least 170 trees (160 live, 10 dead) selected from 54 locations should be selected and destructively sampled for NVAF (Table 6).[8]

3.3.7 Within Polygon Variation Sampling (WPV)

WPV sampling indicates what should be expected in a field inventory "check". It also provides information to estimate individual polygon error, assessed as the difference between adjusted polygon value and "true" value for that polygon based on intensive sampling of sample polygons. Approximately 30 polygons should be selected from the target population (or from the TEP plots) and intensively cruised using a combination of 20-50 full measure and count plots (ratio 1:4) per sample polygon. The measurements should focus on gross volume (no net factoring or call grading) and site index.[9]

3.3.8 Implementation

The timber inventory should be coordinated with photo-interpretation work and be implemented as follows:

- Step 1- a small batch of sample clusters (e.g., 40) should be installed over the target population in the first field season (or first half of field season). Re-calculate the sample size based on new CV estimates.
- Step 2- install remaining plots in the second field season (or the second half of a field season), if required.

A VPIP for ground sampling should be developed following MOF guidelines in *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling*.

3.4 Timber Emphasis VRI – Deciduous Stands

3.4.1 Inventory Objective

The proposed objective of this timber emphasis inventory is to:

> *Improve information on the descriptions (mainly species composition) and the spatial timber distribution of deciduous and mixed deciduous stands in the District.*

[8] The minimum NVAF sample size, recommended by the MOF, is at least 60 trees (50 live, 10 dead) in at least 17 locations.

[9] The field procedures for WPV sampling are available from the MOF RIB (Conact: Dr. Sam Otukol).

This requires improvements (re-typing) of the photo-interpreted estimates for these stands, ground sampling, and statistical adjustment of species composition. Photo-interpretation retrofit can be carried out as outlined in Section 3.2.

3.4.2 Target Population

The target population is all deciduous-leading stands (mainly Aspen) in the District VT database (approximately 239,000 ha; Table 2).

3.4.3 Sample Size

A minimum of 50 sample clusters should be installed in the target population, and proportionally distributed by leading species (Table 7). This sample size should provide sufficient information to statistically adjust species composition in this sub-unit.

Table 7. Approximate distribution of plots in the deciduous stands sub-unit.

Leading Species	Area (%)*	Number of plots
Aspen	86.7	43
Birch	9.8	5
Cottonwood & other**	3.5	2
Grand Total	*100.0*	*50*

*Total area is 239,128 ha (Table 2)
**Douglas fir, yellow pine & willow

3.4.4 Sampling Approach

VRI TEPs should be used to gather timber data following procedures in the current *VRI Ground Sampling Manual*.

3.4.5 Sample Selection

Sample polygons would be selected using the MOF's standard stratified probability proportional to size with replacement (PPSWR) sampling method.

3.4.6 Net Volume Adjustment Factor Sampling

No NVAF sampling would be done. The NVAF factors developed as part of the TEP in the VT area (Section 3.3.6) would be used to adjust the cruiser-called volumes in this sub-unit.

3.4.7 Within Polygon Variation Sampling (WPV)

WPV sampling is not planned at this time.

3.4.8 Implementation

Polygon re-typing should be completed before ground sampling begins. All 50 samples should be installed in one step. A VPIP for the ground sampling should be developed following the guidelines outlined in the MOF document *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling*.

3.5 Management-Unit Monitoring

3.5.1 Overview

The MOF Resources Inventory Branch (RIB) has added an 11.28 m radius fixed-area plot configuration and sampling method to the VRI system. This new plot design, along with other VRI plot types, can be used to estimate and monitor the change over time in timber and non-timber attributes. The new plot design can be implemented over an inventory area in conjunction with or independently of the regular VRI. These plots would be re-measured over time to estimate the change in specific attributes. This system is being applied at the provincial-level by RIB (Change Monitoring and Inventory or CMI) and in some TFLs. Data from the provincial CMI sampling is expected to provide data for the National Forest Inventory and provincial level reporting. The provincial CMI is independent of management unit sampling.

3.5.2 Objectives

The goal of a monitoring program in the District would be to provide non-spatial re-measurement data over time to:

1. *Check growth and yield predictions.*
2. *Meet certification requirements by tracking changes and trends in non-timber values such as wildlife habitat and key biodiversity indicators over time.*

3.5.3 Target Population

The target population would be the entire District landbase including the VT, the vegetated non-treed areas (VnT), and the non-vegetated (NV) areas.

3.5.4 Sampling Unit and Measurements

The sample cluster design is described in the current draft version of the Change Monitoring Inventory sampling manual.[10] This cluster design should be modified by removing the 5.64-m radius subplot. These sample clusters will be established in the VT and VnT areas. Measurements should include tree attributes, plant lists and percent cover, ecological site description, soil description, and coarse woody debris. The observations in the NV samples should involve only checking the landcover classification changes over time; no measurements will be taken in these areas.

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[10] MOF website: **http://www.for.gov.bc.ca/resinv/veginv/Publications.htm.**

3.5.5 Sample Selection

Sample polygons will be selected as a subset from the ground sampling (Phase II) plots. The sample locations in the VnT and NV areas will be selected using the MOF VRI procedures.

3.5.6 Sample Size

A minimum sample size of 100 sample clusters is recommended, with a minimum of 70 in the VT areas and 30 in the VnT areas. These samples should be distributed over the District proportional to the area of land types.

3.6 Implementation Strategy

The stakeholders will identify project implementation priorities. The District may lead this initiative. The District and Region will coordinate stakeholder efforts to develop multi-year VPIPs based on VSIPs for submission to FRBC or other funding agencies. VPIPs identify inventory activities, priority areas, annual costs, and roles and responsibilities for implementation. The VPIPs will link VRI to other Regional FRBC-related (or other agency) initiatives.

3.7 Costs

Estimated sample sizes and preliminary costs for the District VRI activities are listed in Table 8. More accurate and detailed costs should be included in the VPIPs.

3.8 Monitoring

The RIB is responsible for monitoring this VRI planning process and ensuring that the final VSIP is approved (Appendix IV).

Table 8. Estimated sample sizes and costs for VRI in the VFD.

VRI activity	Sample size	Unit Cost ($)	Total Cost ($)
PHOTO INTERPRETATION			
a) **Photography**[11]	6.41m ha	0.12	769,200
b) **Photo retrofit**[12]	6.41m ha	1.00	6,410,000
c) **Finer delineation** (deciduous stands)	239,000 ha	0.60	143,400
Total Photo interpretation			*7,332,600*
GROUND SAMPLING			
d) **TEP**[13]**– Vegetated Treed**			
Phase II Clusters	140	1,500	210,000
NVAF sampling (trees)	170	500	85,000
WPV sampling (polygons)	*30*	*1,500*	45,000
Subtotal TEP – VT			*340,000*
e) **TEP – Deciduous**[14]			
Phase II Cluster	40	1,500	60,000
Subtotal TEP – Deciduous			*60,000*
f) **Monitoring**[15]			
Upgrade TEP in VT areas	70	1,000	70,000
Plots in VnT areas	30	2,500	75,000
Subtotal – Monitoring			*145,000*
Total Ground sampling			*545,000*
OTHER COSTS			
Quality assurance (10% of ground sampling cost)[16]			54,500
Project management (20% of ground sampling cost)[17]			109,000
Statistical analysis			20,000
Total Other			*183,500*
Grand Total			***8,051,100***

[11] The total cost of the photography (1:30,000 color) is broken down as follows: Parks, Protected Areas and Ecological Reserves (886,642 ha) $106,397; Wildland RMZ (1,127,751 ha) $135,330; and Enhanced, Special and General RMZs (4,396,257 ha) $527,551. The total area listed here is 6,410,650ha, which was rounded to 6.41 million ha in Table 8.

[12] This retrofit cost could range from $0.60/ha to $1.00/ha, and excludes cost of photography. In comparison, the cost of new photo-interpretation is approximately $1.60/ha.

[13] Timber Emphasis VRI ground sampling.

[14] These costs are incremental to the approximately 10 TEP plots from the Vegetated Treed ground sampling that fall in this sub-unit.

[15] The Monitoring sample sizes include the sampling needed to upgrade the timber emphasis VRI in VT areas, and new monitoring plots in the non-VT areas.

[16] This quality assurance is for ground sampling only (not photo interpretation). It is done by a check-cruiser, and it involves checking 10% of the field crew work using the MOF quality assurance procedures and standards.

[17] These project management costs are for ground sampling; they will vary by project and how projects are managed (e.g. projects may be managed in-house).

APPENDIX I – STAKEHOLDERS

Table 9. List of stakeholders in the MFD.

Agency	Participant
MOF Mackenzie Forest District	Dave Francis, Steve Dodds, Lorraine Ladds
MOF Prince George Forest Region	Dick Nakatsu, Matt Makar
MOF Resources Inventory Branch	Keith Tudor, Will Smith, Gary Johansen
Forest Renewal BC	Les Herring
BC Ministry of Environment, Lands and Parks	Chris Ritchie, Bill Arthur
BC Parks Service	Mike Murtha, Mark Fercho
Forest Companies	
Slocan Forest Group Inc.	Leslie Yaremko, Randy Hart
Abihiti Consolidated Inc.	Wayne Lewis, Shirley Gilmour

APPENDIX II – GLOSSARY OF TERMS

Change Monitoring and Inventory

Change Monitoring and Inventorying (CMI) is the process of estimating and monitoring the change over time in timber and non-timber attributes, based on repeated measurements of the same objects over a time series. The MOF Resources Inventory Branch is currently implementing the CMI over the province. The provincial procedures can also be deployed to address management-unit level monitoring objectives.

Ground Sampling

Ground sampling is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. Sample polygons are selected using the probability proportional to size with replacement (PPSWR) method. To accommodate a wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

Inventory Unit

An inventory unit is the target population from which the samples are chosen. The inventory unit could be a specific a geographic area (e.g. TFL or TSA) where a specific set of attributes is needed. The size of the inventory unit depends upon the sampling objectives.

Landcover Classification

The BC Land Cover Classification Scheme (BCLCS) was designed specifically to meet VRI requirements, in addition to providing general information useful for "global vegetation accounting" and "integrated resource management." The BCLCS is hierarchical and reflects the current state of the landcover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

Management VRI

Management VRI are specialized inventories that provide detailed information required for specific resource management, i.e., day-to-day forest management. One or more VRI sampling procedures may be used for management inventories. Management inventories may focus on specific resource types (e.g., timber, range, ecology), geographic areas (e.g., landscape unit, TFL), attribute sets (e.g., Douglas-fir leading stands, age class 4+). They may use one or more of the following tools (e.g., photo-interpretation, ground sampling, NVAF sampling).

National Forest Inventory (NFI)

The NFI provides information on Canada's resources across all provinces and allows the Federal Government a consistent framework for reporting on Canada's inventory, including reporting on the Criteria and Indicators and the Kyoto protocols. The inventory unit for the NFI is the entire country, although it is implemented province-by-province. BC's provincial CMI system will provide the data needed for the NFI as well as provincial reporting.

Net Volume Adjustment Factor (NVAF) Sampling

NVAF sampling provides factors to adjust net tree volume estimated from net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimated net volume is obtained from net factoring and taper equations). The NVAF (and VRI net factoring) replaces the existing loss factors for inventory applications. It does not, however, replace the loss factors for revenue applications.

Photo-Interpretation

Photo-interpretation involves subjective delineation of polygons and photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in photo-interpretation. However, if existing photo-based inventory is acceptable, the database can be translated into VRI format and upgraded to include the additional VRI attributes.

Post-Stratification

Post-stratification involves dividing inventory unit into mutually exclusive sub-populations (strata) *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately and the results are applied to the corresponding population post-strata to improve the precision of the inventory's overall averages and totals.

Pre-Stratification

Pre-stratification divides an inventory unit into mutually exclusive sub-populations (strata) *before* ground sampling to provide estimates for specific areas, or to increase the confidence in the overall estimates by considering special characteristics of each stratum.

Resource-Specific Interpretations

Resource-Specific Interpretations (RSI) use the Resource Inventory Committee (RIC) standard VRI baseline data products (provincial CMI or management inventory), in combination with other data sets and analysis (outside of that required to produce VRI), to produce information to address specific-resource management issues (e.g., TSR review, important ecosystems and habitats). These interpretations include ecosystem interpretations and habitat interpretations.

Retrofit

Retrofitting is the process of translating and upgrading an existing photo-based inventory to VRI Phase I standards. If the polygon linework and attributes are of acceptable quality, the existing FIP (Forest Inventory Planning) databases are translated to VIF (Vegetation Inventory Files) databases and the additional attributes required by the VRI are re-estimated from aerial photographs.

Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet the target precision.

Statistical Analysis

Statistical analysis or adjustment is the process of adjusting the values of the photo-interpretation variables using ground sampling observations. Ground observations are compared to photo-estimated values to develop adjustment factors by species groups. These factors are then applied to the polygons in the photo interpretation database to produce the final adjusted database.

Sub-unit

Sub-unit describes the inventory unit within an Inventory Unit. For example, if the inventory unit is defined as the Vegetated Treed area in a Forest District, then a sub-unit may be defined by a specific geographic area (e.g., operable landbase) or stand type (e.g., problem forest types) within the Vegetated Treed area in the Forest District.

Target Precision

Target precision expresses the amount of variation in key attributes (e.g., timber volume) desired in the final results. Target precision, usually expressed as the coefficient of variation (CV), is used to calculate the minimum sample size for subsequent ground sampling. The current target precision for timber volume is $\pm$10% (90% or 95% probability); stakeholders define the probability (uncertainty) level.

Vegetation Resources Inventory (VRI)

VRI is an improved vegetation inventory process for assessing quantity and quality of BC's vegetation resources. The VRI process is designed to include a flexible set of sampling procedures for collecting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- *Photo-interpretation*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- *NVAF Sampling*: stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- *Statistical Adjustment*: the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit using the values measured during ground sampling.

The VRI can be deployed over the entire province measuring timber and non-timber resources, or over a large management unit (management VRI) measuring selected resources in specific portions of the landbase. The VRI sampling process produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.

Within Polygon Variation Sampling

WPV sampling provides information for expressing the true individual polygon error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon. The "true" value for the polygon is an estimate derived from a small sample of polygons that are intensively sampled on the ground.

APPENDIX III – VRI & POST VRI COMPONENTS, STEPS, ROLES, AND RESPONSIBILITIES

The VRI is undertaken in the context of business needs, and the need for baseline vegetation inventory data. VRI and post-VRI information is developed to address issues identified in the planning processes. Many components are involved: 1) developing VRI baseline data products (as defined by RIC standards), and 2) developing VRI-based information products (e.g., maps for timber, ecosystems, habitat, etc.) to address the issues (as defined by RIC or Ministry standards). The objective of this Appendix is to provide an overview and identification of all the components, their sequence, and tentative participant roles for both VRI and post-VRI information development.[18]

These components include:

VRI

a) Development of procedures and standards to undertake the VRI
b) VRI strategic planning
c) VRI District operational planning
d) Implementation of management VRI, sub-district

Post-VRI

e) Implementation of management inventories
f) Ecosystem and habitat mapping (information development)
g) Land integration planning

Each of these components, and the responsible and participating/supporting agencies, are summarized in Table 7. Note that the responsible and participating/supporting agencies will vary among Regions and among projects, depending on funding scenarios and workloads of the various agencies.

[18] The first draft of this Appendix was prepared by Ron Kot, MELP.

Table 10. Overview of VRI components, steps, and example of roles and responsibilities.

Inventory Component	Responsible Agency	Participating/ Supporting Agencies
VRI		
A. Production of VRI Procedures and Standards		
1) Photo interpretation	MOF	MELP
2) Ground sampling	MOF	MELP
3) Quality Assurance	MOF	MELP
4) Net Volume Adjustment Factor (NVAF) sampling	MOF	
5) Within Polygon Variation (WPV) sampling	MOF	
6) Data and warehouse standards and quality control procedures	MOF	
7) VRI Change Management Process	MOF	
B. VRI District-level Strategic Planning		
Development of VSIP	MOF (RIB) leads	Stakeholders: Industry, MOF, MELP, other agencies,
C. VRI Operational Planning		
1) Development of VPIPs	MOF (District) approves, industry/proponent (could be MOF) prepares	Stakeholders: Industry, MOF, MELP, other agencies
2) Funding Responsibility & Lead Proponent		
- TFLs	Licensee	
- TSA	MOF	
3) Submission to FRBC or other funding agency.	Lead Proponent	MOF, other stakeholders
D. "Provincial Change Management and Inventory" (CMI)		
1) VRI Implementation	MOF (RIB)	
2) VRI Data Warehouse (Data products "Custodianship")	MOF (RIB)	
E. "Management VRI" Sub-district Inventories		
1) VRI Inventory Implementation		
-TFLs	Licensee	
-TSAs	MOF	MELP and other agencies?
2) VRI Data Warehouse (Data products "Custodianship")	MOF/Licensee All products to MOF RIB data warehouse?	
POST - VRI		
F. Resource-specific Information Development		
1) Timber Information Development	MOF/Licensee (TFL)	
a) Methods and standards	MOF	
b) Inventory needs id and planning –Strategic	VRI Plan	

Inventory Component	Responsible Agency	Participating/ Supporting Agencies
c) Inventory needs id and planning – Operational	VRI Plan	
d) Funding / funding submission		
e) Undertake Inventory		
- TFL	Licensee MOF	
- TSA		
f) Warehousing products ("Custodianship")	Licensee/ (MOF)?	
2) Ecosystem and Habitat Mapping and Information Development		
a) Methods and Standards	MELP steward	
b) Inventory needs id and planning - Strategic	VRI Plan	
c) Inventory needs id and planning - Operational	VRI Plan	
d) Funding submission (100% FRBC fundable)	Proponent: Licensee?	
- TFL	MELP?	
- TSA		
e) Undertake Inventory		
-TFLs	Licensee	MELP
-TSAs	MELP	MOF
f) Warehousing products ("Custodianship")	MELP custodian	
G. Land Integration Planning		
Management strategies and prescriptions	Licensee/MOF	MELP

APPENDIX IV – APPROVAL/SIGNING

I have read and concur with the Mackenzie Forest District VRI Strategic Inventory Plan, dated XXXX, 2000. It is understood that this is an agreement-in-principle and does not commit the signatories to completing the inventory activities outlined within the plan. Modifications to this plan or more detailed plans need to be reviewed and approved by the signatories.

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District Manager
Mackenzie Forest District

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Regional Manager
Prince George Forest Region

_____

Director
Ministry of Environment, Lands and Parks, Resources Inventory Branch

_____

Director
Ministry of Forests, Resources Inventory Branch

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Slocan Forest Group, Inc.

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Abihiti Consolidated, Inc.